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OCCUPATION, PERSONALITY, AND ACCIDENTS: AN EXPLORATORY STUDY OF AGGREGATE ASSOCIATIONS

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Summary

Background

Accidental injury is a significant concern for the U.S. Navy. The recent magnitude of the problem in the Department of Defense has been sufficient for the Secretary of Defense to set a goal of reducing the injury rate by 50%. The underlying causes of accidents must be fully understood to pursue this goal efficiently. Previous research suggests that risk takers seek out hazardous occupations. If so, the preferred behavior patterns of those individuals could be a barrier to effective safety programs in occupations where effective programs are needed most.

Objective

This study investigated personality as a factor in the variation of accident rates across U.S. Navy enlisted occupations.

Methods

Thirty-six entry-level U.S. Navy enlisted occupations were studied. The average personality test scores of a small sample of occupational incumbents defined a personality profile for each occupation. The personality test scores were obtained before the individuals who were tested entered the occupation. Job demands, measured by ratings from senior enlisted personnel in each occupation, were included to control for job-related risk of injury. Accident rates were determined from hospitalization data from 1970–1974 and 1980–1994. Each period was treated separately to replicate associations to personality or job demands. Correlations, partial correlations, and regressions described the relationships of accident rates with personality and job demands.

Results

Controlling for job demands, higher accident rates were reliably related to higher hostility, impulsiveness, excitement seeking, and disagreeableness and to lower gregariousness.

Conclusions

The personality composition of an occupational population is related to the occupational accident rate. The specific personality variables involved suggest that the relationships could reflect processes occurring at the individual level. Angry, hostile people who are suspicious and rude to those around them are known to engage in behaviors that increase the risk of accidents. Similarly, some people will take chances in a search for excitement. Any occupation with more of these individuals would be expected to have higher accident rates. However, it is important to consider other possible explanations based on how the behavior of these high-risk individuals affects others in the population. Their behavior should produce secondhand risk to others around them. Their behavior also may encourage others to behave similarly. An accurate model of accidents may have to combine these explanations with hazard exposures. The result may be analogous to a model of traffic safety that considers the risky behavior of some drivers, how other drivers react to them, the effects on passengers and bystanders, and how environmental factors set a basic risk level and modify the consequences of high-risk behavior. The model would have implications for safety programs. The high-risk personality describes people who intentionally flout rules, including safety rules, so understanding how this type of individual reacts to safety programs may be essential to maximizing the return from those programs.

Introduction

U.S. Navy enlisted occupations have widely varying accident rates. Ferguson, McNally, and Booth (1985) reported that those occupations with high on-duty rates also have high off-duty rates. This convergence could be explained by a tendency for risk takers to choose hazardous occupations, but this hypothesis has not been tested. This study provided a preliminary test of the hypothesis by relating occupational accident rates to occupational personality profiles.

The study of aggregate accident rates and aggregate personality profiles is exploratory. This approach deviates from the common practice of treating personality as a variable that has meaning only as an individual difference variable. In that tradition, personality–accident research focuses on showing that the personalities of individuals who have accidents differ from those of people who are accident free. The underlying causal model assumes that the behavior of the individual increases his or her risk for accidents.

The individual differences approach to personality and accidents can be difficult to conduct. Accidents are infrequent, so individuals must be studied for extended periods of time to establish which ones have more accidents than would be expected by chance. Longitudinal studies of individuals are costly and difficult to conduct.

The aggregate differences approach to personality and accidents may complement the individual differences approach. The approaches are complementary in two respects. To begin with, aggregation can be a useful tool for examining relationships that reflect processes at the level of individuals within a group. In this role, aggregation provides a different way to generate the cumulative volume of observation needed to estimate the accident rate associated with a given personality score with precision. This outcome arguably arises if 2 conditions hold. First, people with the same score on a personality measure are interchangeable in the sense that the score carries the same implications for accidents for each of them.[1] In this case, the same observational volume for that behavior pattern is generated by studying one person over a long time period or a set of equivalent people over a shorter time period. Second, the accident rate must be linearly related to scores on relevant personality dimensions. When this condition holds, the average score for a population composed of people with different scores will be an accurate index of the cumulative accident probability for the group. When these conditions are satisfied,

[1] This does not mean that each individual will have the same risk of accidents. Other personality components and differential exposure to hazards could produce variable risk within a group of people who had the same score on a personality test. The equivalence is properly formulated as equal risk holding other factors constant.

groups with higher average scores on personality attributes that affect accident rates will have higher or lower accident rates. The direction of association depends on whether the personality attribute in question increases or decreases the likelihood of accidents. This cumulative aggregate effect of individual personality dynamics is referred to here as a composition effect.

Routinely interpreting aggregate correlations in terms of population composition will lead to errors. The atomistic fallacy occurs when aggregate associations are incorrectly interpreted as the product of individual dynamics (Diez-Roux, 2002). Routine application of a composition interpretation will produce this fallacy whenever associations are wholly or partly the result of aggregate dynamics. Two types of aggregate dynamics are suggested as plausible factors in accidents. Behavioral contagion occurs when an individual emulates another person's behavior, particularly delinquent behavior (Jones & Jones, 1995; Rodgers & Rowe, 1993). Secondhand risk occurs when one person's behavior increases the probability of adverse events for others in the immediate area. These mechanisms are analogous to the effects of smoking, which is among the behaviors that have been characterized as contagious, and produces well-known secondhand effects. These mechanisms logically extend to other behaviors, including risk-taking behaviors. For example, secondhand risk is implicit in studies that relate a driver's risky behaviors to the probability of accidents for passengers, other drivers, and pedestrians (Braver & Trempel, 2004). Secondhand risk has also been mentioned in connection with alcohol consumption (Vicary & Karshin, 2002), a behavior that increases accident rates. While analogies must be treated with caution, similar effects could be expected if a person takes risks on the job. People also seem more likely to socialize with co-workers than with people they do not know. Being in an occupation that includes high-risk individuals therefore could increase the likelihood of secondhand risk and behavioral contagion both on and off the job. As a consequence, both behavioral contagion and secondhand risk could increase the accident rate in populations that possess a higher proportion of people whose personality characteristics predispose them to take risks.

A full model of behavioral risk and accidents may involve processes at both levels of analysis. The two levels of explanation are not mutually exclusive. As an example from everyday experience, consider the risk of an automobile accident. The risky behavior of a driver will increase the probability that he or she will have an accident. This same risky behavior will increase the probability of an accident for passengers, other drivers, and pedestrians. The risky behavior may also modify the behavior of other drivers who respond with similar behavior (i.e., road rage) or have to take extraordinary actions that increase risk in order to compensate for problems raised by the risk taker's behavior. Aggregate correlations (also known as ecological correlations) between personality and accident rates can be one basis for formulating models that consider these secondary effects.

Aggregation apparently has not been used previously to study personality–accident relationships. Aggregate associations have been used to relate organizational climate to accident rates (Harter, Schmidt, & Hayes, 2002; Zohar, 2000, 2002). Also, the personality profiles of individual managers have been shown to predict the aggregated accident rates of their subordinates (Janicak, 1996). However, a literature search failed to identify any studies relating aggregate personality profiles to accident rates. This gap may reflect the obvious point that personality clearly is an attribute of an individual rather than a population. Nevertheless, under simple assumptions such as those spelled out above, individual-level dynamics can lead to aggregate-level associations. Also, the behavioral contagion and secondhand risk hypotheses illustrate the potential for a better understanding of accidents. Some people may be injured because they imitate behavior that they see around them. These behaviors may be guided by informal work group culture or norms. In the extreme, the behavior may become a target of social pressure. In other cases, people may be injured because the behavior of others increases their risk. Explanations based on the personality dynamics of the individual person provide a simple model, but one that quite probably has limited verisimilitude. Recognizing that any behavioral model only approximates the full complexity of the phenomena under investigation (MacCallum, 2003), the question is whether a model that does not consider aggregate dynamics will have sufficient verisimilitude to be good enough (Serlin & Lapsley, 1985). Informal everyday observations, news articles, and other sources of information make it likely that aggregate effects will have to be considered to achieve a sound model of accidents.

The lack of personality–accident studies that rely on aggregated units of observation may not be entirely the product of conceptual blinders. Researchers seldom can collect data from all or even most of the people in a population. Instead, populations are represented by samples that not infrequently consist of a very small proportion of the total population. Small samples imply imprecise estimates of the population personality profile. Imprecision will obscure relationships between personality and accident rates. The personality profiles in this study are based on small samples in most of the occupations studied, so it can be regarded as a feasibility study. The general hypothesis was that personality variables correlate with accident rates at the level of U.S.

Navy occupations. Significant associations would illustrate the utility of this methodology as a basis for accident models. Until this approach has been applied, the feasibility of aggregate-level research on personality–accident relationships is not known.

Methods

Sample

The sample consisted of 36 entry-level U.S. Navy enlisted occupations. This set included all U.S. Navy enlisted occupations for which both job demand ratings and personality profiles were available. The sample included only entry-level occupations because demand ratings were available only for those occupations.

Occupational Personality Profiles

Archival NEO Personality Inventory (NEO-PI; Costa & McCrae, 1985) data for 3,932 U.S. Navy males provided the personality profiles. This inventory had been selected for an earlier study because it was the first standardized inventory based on the five-factor model (FFM) of personality (cf., John & Srivastava, 1999), a measurement framework now widely used to organize findings from personality research relating to such diverse topics as personality disorders (Saulsman & Page, 2004), leadership (Judge, Bono, Ilies, & Gerhardt, 2002), antisocial behavior (Miller, Lynam, & Leukefeld, 2003), and counterproductive behaviors (Salgado, 2002), in addition to earlier work on job performance (Barrick & Mount, 1991; Tett, Jackson, & Rothstein, 1991; Salgado, 1997). When the data were collected, the NEO-PI consisted of 180 items. Three domains, Neuroticism, Extraversion, and Openness to Experience, were represented by 8 items for each of 6 specific personality facets. The facet names can be found in Table 1. The NEO-PI did not provide facet scales for the Agreeableness and Conscientiousness domains. Each overall domain scale consisted of 18 items. The 18 items in each domain were divided into 2 subscales to approximate the finer analysis possible within the other domains. An examination of the pattern of interitem correlations produced 2 subscales within each domain. One subset of agreeableness items emphasized positive views of people and behavior that would smooth interactions (items 95, 105, 115, 120, 155, 165, and 175). The other subset of agreeableness items described a person who was rigid, argumentative, cynical about others and willing to show it, and manipulative (items 100, 130, 135, 145, 150, 160, 170, and 180). These item subsets were labeled Agreeable and Disagreeable, respectively. One subset of conscientiousness items emphasized working hard to achieve goals with a high level of excellence and to consistently fulfill obligations (items 15, 20, 25, 35, 45, 55, 60, 75, and 85). The other subset of conscientiousness items described a person who was neat, organized, and methodical (items 5, 30, 65, 70, and 80). The subscales formed from these items were labeled Reliable and Orderly, respectively. Adding these 4 composites to the 5 NEO-PI factor scales and 18 NEO-PI facet scales produced a final set of 27 personality measures.

A personality profile was constructed for each Navy Enlisted Classification represented by 10 or more cases in the archival data. This sample size restriction was an attempt to ensure reasonable measurement precision for the personality profiles. The rationale was that the standard error of the mean for a personality scale is one third of a standard deviation when N = 10. When considering scores for individuals, individual differences would have to account for an estimated 89% of the variance to a standard error of measurement of this size.

General Mental Ability

Scores for the Armed Forces Qualifying Test (AFQT), a measure of general mental ability, had been extracted from the Career History Archival Medical and Personnel System (CHAMPS; Gunderson, Garland, Miller, & Gorham, 2005). This system combines hospitalization data with demographic and administrative data (e.g., promotions, occupational classification). The AFQT provides scores that are comparable to those from other measures of general intelligence (Ackerman, 1988).

Job Demand Ratings

Job demand ratings were included in the study to control for one important element of risk exposure. Job demands predict occupational differences in accident rates (Vickers, Hervig, & White, 1997; Vickers & Hervig, 1998; Vickers & Hervig, 1999). A causal influence of job demands on accidents is a plausible interpretation of these associations (Bernard, 1997). Ferguson et al.’s (1985) risk-taking hypothesis suggests that personality traits may correlate with job demands. Given these considerations, spurious personality–accident correlations could arise because personality was confounded with job demands (Kenny, 1979). This possibility could be evaluated by including job demands in the analyses.

The job demand ratings came from Reynolds, Barnes, Harris, and Harris (1992). In their study, senior enlisted personnel familiar with the tasks in each entry-level U.S. Navy enlisted occupation completed the Job Activities Inventory. One section of this inventory asked the raters to describe their occupation in terms of 27 different job-related abilities. Ratings were made on a 5-point scale with “Not Very Important,” “Somewhat Important,” “Important,” “Very Important,” and “Extremely Important” as response anchors. These responses were scored 1, 2, 3, 4, and 5, respectively. Respondents also could choose a “Not Applicable” response. This response was scored 0 when computing occupational scores.[2] These ability requirements were used as indicators of hazard exposure.

This study only used ability ratings that had predicted accident rates in an earlier study (Vickers & Hervig, 1998). *Physical Demand* was the average of 4 rating items: (a) Strength: ability to use muscle force in order to lift, push, pull, or carry heavy objectives for a short period of time; (b) Flexibility: ability to bend, stretch, twist, or reach out with the body, arms, or legs; (c) Body Balance: ability to keep or regain one’s balance or to stay upright when in an unstable position; and (d) Stamina: ability to exert oneself physically without getting out of breath. These items were very highly correlated and defined a single dimension when demand ratings were factor analyzed by Reynolds et al. (1992). *Reaction Time*, a second predictor of accident rates, was represented by a single item, “Ability to give a fast response to a signal (sound, light, picture) when it appears.” Vickers et al. (1997) provided additional details on the selection rationale.

Occupational Accident Rates

Accident rates were the hospitalization rates for males in the occupations being studied. Ferguson et al. (1985) provided rates by occupation for the period from 1970 through 1974.[3] Jaeger, White, and Show’s (1996) Epidemiological Interactive System (EPISYS) relational database provided rates for the period from 1980 through 1994. This system utilizes data from the CHAMPS database (Gunderson et al., 2005). The analysis was restricted to men because Ferguson et al. only studied men. EPISYS could have provided rates for both men and women, but the rates would have been based on very small sample sizes. Restricting the analyses to men provided the opportunity to directly test the temporal generalizability of any personality–accident relationships.

[2] Reynolds et al. (1992) omitted these responses. This approach biases the demand ratings upward if some respondents truly feel the ability is not relevant to the job.
[3] Ferguson et al. (1985) also reported results by duty status. This variable did not affect the results. The general pattern of associations to personality was the same as the overall accident rate for both on-duty and off-duty status. The differences for specific personality variables were modest. Without replication, chance was a plausible explanation for these duty status effects, so this issue was not considered further.

The diagnostic codes of the International Classification of Diseases (Medicode, Inc., 1991) were the basis for identifying accidental injuries. Given the time span for the hospitalization data, these codes would be based on both Versions 8 and 9 of the classification.

Analysis Procedures

Correlation and regression, the primary data analysis procedures, were conducted with SPSS-PC (1998a, 1998b). Effect size (ES) was defined by Cohen's (1988) criteria: trivial, $|r| < .10$; small, $.10 \leq |r| < .30$; moderate, $.30 \leq |r| < .50$; and strong, $|r| \geq .50$). Significance tests were 1-tailed because the literature provided directional hypotheses for some variables (e.g., excitement seeking, hostility). The use of a 1-tailed test employed this knowledge while applying a uniform significance criterion to all of the correlations. A lenient criterion also made it unlikely that any unanticipated relationships would be overlooked in this exploratory evaluation of aggregate correlations as a methodology for personality–accident research. Even with this criterion, an association had to be near the upper boundary of the range for a small ES to meet the significance criterion. Any ES this size seems worthy of further study, particularly when there is evidence that it is a replicable finding. The two time periods provided partially independent replication in these analyses. Ultimately, the criterion for singling out an association as important was that it represented a moderate ES that was stable over time.

Regression analyses were used to determine the cumulative predictive accuracy of facets within a domain when more than 1 facet was related to the accident criterion. These analyses employed forward stepwise selection of predictors using a sequential Bonferroni procedure (Green, Thompson, & Poirer, 2001). The analyses weighted the data for each occupation by the number of years of observation for that occupation in Ferguson et al. (1985). These weights were highly correlated with weights based on years of observation in the EPISYS data ($r = .974$). These weights were used to optimize the estimated correlations. Significance tests were based on a sample size of 36 occupations.

Results

The Openness to Experience domain was the primary source of significant bivariate associations (Table 1). The typical association was replicable and moderate in magnitude. The associations were significant for both accident criteria for the domain scale and for 5 of 6 facet scales.

Associations tended to be limited to specific facets in the other FFM domains. The Neuroticism domain scale was a reliable predictor of accident rates, but the Hostility

Table 1. Correlation of Personality Variables with Accident Rates

	Bivariate		Controlling for Job Hazards[a]	
Period[b]	**1**	**2**	**1**	**2**
Neuroticism	.258	**.345**	**.346**	**.490**
Anxiety	-.009	.180	.060	**.322**
Angry Hostility	**.412**	**.484**	**.318**	**.488**
Depression	**.294**	.268	**.321**	**.296**
Self-consciousness	.094	.141	**.292**	**.335**
Impulsivity	.088	.133	**.415**	**.478**
Stress Vulnerability	.155	**.279**	.101	**.295**
Extraversion	.055	-.015	-.006	-.129
Warmth	.022	-.098	.041	-.127
Gregariousness	-.151	-.099	**-.435**	**-.321**
Assertiveness	**-.298**	**-.319**	-.251	**-.293**
Active	.170	.062	.112	**.350**
Excitement Seeking	**.428**	**.417**	**.355**	**.318**
Positive Emotion	.074	-.036	.088	-.107
Openness	**-.442**	**-.469**	-.040	-.167
Fantasy	-.128	-.267	.070	-.148
Aesthetics	**-.365**	**-.284**	.059	.085
Feelings	-.269	**-.323**	.138	-.018
Action	**-.399**	**-.467**	-.187	**-.336**
Ideas	**-.457**	**-.472**	-.149	-.244
Values	**-.377**	**-.361**	-.033	-.065
AFQT[c]	**-.510**	**-.471**	-.196	-.010
Agreeableness	-.195	-.273	-.163	-.278
Agreeable	.210	.108	.238	.067
Disagreeable	**.456**	**.501**	**.473**	**.508**
Conscientiousness	.073	-.157	-.033	**-.348**
Reliable	.197	-.043	.049	-.287
Orderly	-.080	-.203	-.099	-.277

Note. Boldface indicates the correlation was significant at $p < .05$, 1-tailed (see Methods).
[a]Partial correlations controlling for Physical Demand and Reaction Time.
[b]Period 1 = 1970–1974; period 2 = 1980–1994.
[c]The Armed Forces Qualifying Test (AFQT) has been grouped with the Openness to Experience variables because intelligence is more strongly related to personality variables within this domain than within other domains (Ackerman & Heggestad 1997).

facet was a stronger predictor for both accident criteria. The domain scale was not a reliable predictor of accident rates in any of the 3 remaining domains. However, Assertiveness and

Excitement Seeking were moderately strong predictors in the Extraversion domain. The associations between Disagreeableness and accident rates were near the upper boundary of the moderate effect size.

Controlling for Job Hazard Exposure

Partial correlations controlling for Physical Demand and Reaction Time were computed to determine whether personality was related to accident rates controlling for job hazard exposure. Controlling for hazard exposure is a general concern in accident research, but it is particularly important in this study. A risk-taking explanation assumes that personality is related to occupational accident rates because risk takers choose to enter hazardous jobs. If so, occupational exposure is an intervening variable connecting personality to accidents. Relationships to personality should be weaker controlling for this intervening variable (Heise, 1975).

Substantial effects of controlling for hazard exposure were found in the Openness to Experience and Neuroticism domains. The moderately large bivariate associations in the Openness domain generally were reduced to trivial associations. Controlling for hazard exposure generally increased the size of associations in the Neuroticism domain. Another change was that the partial correlations for the Neuroticism domain scale were stronger than those for any single facet, although the partial correlations for the Hostility and Impulsiveness facets were nearly as large. The only other noteworthy effect of controlling for hazard exposure was the addition of Gregariousness to the list of moderately strong predictors.

Within-Domain Analyses

Additional analyses explored the combined predictive power of facets within the neuroticism and extraversion domains. The combined predictive power of the facets would provide a better basis for evaluating the relative value of models based on domain-level and facet-level predictors. These analyses were limited to the neuroticism and extraversion domains because these domains were the only ones with multiple facets that predicted accidents. The analyses included Physical Demand and Reaction Time as control variables in addition to personality facets. Results were:

Neuroticism: Impulsiveness was more strongly related to accident rates controlling for Hostility (period 1, partial r = .337; period 2, partial r = .365) than was Hostility controlling for Impulsiveness (period 1, partial r = .193; period 2, partial r = .380). No other facet was reliably related to accidents controlling for either Hostility or Impulsiveness.

Extraversion: Excitement Seeking was related to both accident rates controlling for Gregariousness (period 1, partial r = .355; period 2, partial r = .318). The same was true for Gregariousness controlling for Excitement Seeking (period 1, partial r = -.414; period 2, partial r = -.293). No other facet was reliably related to accidents controlling for these two facets.

Level of Analysis Comparison

In the analyses that controlled for hazard exposure, the Neuroticism scale predicted accidents better than any facet scale in that domain. This aspect of the findings suggested that the relationship of neurotic tendencies to accidents was a general tendency that encompassed all elements within the domain. However, Hostility and Impulsivity were nearly as strongly related to accident rates in the same analyses. If these facets contributed independently to the prediction of accident rates, a facet-level model would provide a better representation of the data. These alternatives were compared by examining the increase in the adjusted R^2 when personality predictors were added to a regression model that already included Physical Demand and Reaction Time. The comparisons employed the adjusted R^2 to allow for the fact that 2 parameters were added to the facet-level model while only 1 parameter was added to the domain-level model.

The facet-level model was better than the domain-level model. The adjusted R^2 increased an average of .082 (period 1, .039; period 2, .124) when Neuroticism was added. The average increase was .118 (period 1, .065; period 2, .170) when Hostility and Impulsiveness were added. The difference in the average values amounted to a small ES for the additional degree of freedom.

The superiority of the facet scales as predictors in the extraversion domain was evident in Table 1. However, a domain-facet comparison was made to complete the analyses. The comparison included determining the combined predictive value of the Gregariousness and Excitement Seeking controlling for hazard exposure. Adding the Extraversion domain scale to the equation added nothing to the accuracy of the predictions. In fact, both adjusted R^2 values were less than those obtained with the job demands alone (period 1, -.014; period 2, -.008). In this case, the reasonable conclusion is that adding the Extraversion domain scale accounted for zero additional variance. In contrast, adding Gregariousness and Excitement Seeking increased the adjusted R^2 by an average of .085 (period 1, .098; period 2, .071).

Discussion

The study of ecological correlations appears to be a useful approach to personality–accident research. This study produced moderate correlations despite design factors that might have attenuated relationships. The personality profiles were based on small samples. The personality measurements were not contemporaneous with the accident criteria. Eliminating these flaws might have produced stronger associations, but the presence of significant associations despite design limitations may be more important as a clue to the value of ecological research in this domain. Viewed in light of the design limitations, the findings increase the range of research designs that can be employed in this type of research.

The pattern of personality–accident relationships was broadly consistent with previous research findings. The present ecological correlations associated higher accident rates with higher Hostility, higher Impulsivity, higher Disagreeableness, and lower Gregariousness. Costa and McCrae (1985, p. 2) would characterize a person with those attributes as hot-tempered, angry, easily frustrated, unable to resist cravings, and susceptible to urges. Interpersonally, this individual would be cynical, rude, suspicious, uncooperative, vengeful, ruthless, irritable, manipulative, solitary, and self-contained. He or she would avoid crowds and prefer being alone.

The preceding description is very similar to profiles based on clinical assessments of individuals who are susceptible to accidents. Donovan, Marlatt, and Salzberg (1983), summarized projective test results reported by Shaw (1965) as showing that:

> …individuals with a high accident risk were emotionally unstable, exhibited uncontrolled aggression, had pronounced antisocial attributes, were selfish, self-centered and irritable, harbored grudges and resentments, and were intolerant, impatient, and sensitive to criticism (Donovan et al., 1983, p. 404).

Donovan et al.'s (1983) summary of the findings from clinical interviews conducted by Conger, Gaskill, Glad, Hassel, Rainey, and Sawyer (1959) echoed the themes of aggression and interpersonal conflict:

> In contrast to nonaccident-involved subjects, the accident-involved subjects were found to have less capacity for controlling or managing hostility, to be excessively self-centered and indifferent to the rights of others, to be more angry and resentful toward individuals viewed as depriving, to be less able to tolerate tension without discharging it immediately, to be more frequently belligerent or covertly hostile. (Donovan et al., 1983).

These clinical portraits have not lost their relevance as descriptions of the at-risk individual during the years since their publication. Anger, hostility, and aggression as correlates of accidents are continuing themes in studies with individuals as the unit of observation (e.g., Begg & Langley, 2004; Deffenbacher, Lynch, Filetti, Dahlen & Oetting, 2003).

Sensation seeking, excitement seeking, and related tendencies are conspicuously absent from the preceding descriptions of the high-risk individual. The present ecological correlation of higher accident rates with higher NEO-PI Excitement Seeking scores underscores this omission. Individuals who receive high scores on this Excitement Seeking are often described as flashy, seeking strong stimulation, and risk takers (Costa & McCrae, 1985, p. 2). This association is not unique to the present study. A substantial body of evidence documents an association of excitement-seeking tendencies with accidents when individuals are the basic unit of analysis (Jonah, 1997). The absence of this characteristic from the clinical descriptions of high-risk individuals may mean that excitement seeking is a distinct personality influence on accidents and operates independently of the hostile/aggressive pattern. However, excitement seeking may be part of a broader personality style that includes hostility and aggression. This element may have been overlooked or discounted in the clinical assessments. If so, excitement seeking might be an energizing or motivating element of the style.

The pattern of associations between personality and accidents is similar for individuals and occupations. This similarity makes it tempting to assume that personality dynamics are the common basis for both sets of relationships. The temptation should be resisted because group dynamics hypotheses are plausible. The effect of one person's behavior on risks for others has been demonstrated in connection with automobile accidents (Braver & Trempel, 2004).

Secondhand risk has been mentioned in alcohol research (Vicary & Karshin, 2002). Behavioral contagion has been documented for a variety of behaviors that share a common element of disregard for rules and guidelines (Greene, Krcmar, Walters, Rubin, & Jerold, 2000; Jones & Jones, 1995; Rodgers & Rowe, 1993). Failure to follow safety rules could be an expression of a broad pattern of delinquency or deviance (Dunlop & Lee, 2004; Rotundo & Sackett, 2002). In the extreme, safety rules may be deliberately ignored as a form of sabotage (James, McIntyre, Glisson, Bowler, & Mitchell, 2004). Ecological correlations are inherently ambiguous, but they do serve as a reminder that the simplicity of the unifying perspective provided by a pure individual differences approach to the psychosocial dynamics of accidents must be weighed against risks that include confirmation bias (MacCallum & Austin, 2000) and the atomistic fallacy (Diez-Roux, 2002).

Recent advances in multilevel modeling provide the analytic techniques needed to properly test models that combine group and individual dynamics (Diez-Roux, 2000; Raudenbush & Bryk, 2002). Several design issues should be considered in applying these methods to the study of occupational differences in accident rates. A broad spectrum personality model should guide the sampling of personality measures because useful predictors are found in several different domains. Recent studies using the five-factor model illustrate this approach (Arthur & Doverspike, 2001; Arthur & Graziano, 1996; Cellar, Nelson, & Yorke, 2002; Cellar, Nelson, Yorke, & Bauer, 2001; Cellar, Yorke, Nelson, & Carroll, 2004). The facet level of analysis should be considered in sampling the personality domain and analyzing the data (e.g., Vollrath, Landolt, & Ribi, 2003). Facets generally provide better prediction of behavioral criteria (Mershon & Gorsuch, 1988; Hogan & Holland, 2003). One reason is that associations to criteria are not homogenous within domains. The extraversion domain provided the best example in the present data. Excitement Seeking had a strong positive relationship to accidents and Gregariousness had a strong negative relationship, while the overall Extraversion score was virtually independent of the rates.

Omitted variable bias should be a concern in study design. Facets are correlated within domains (Costa & McCrae, 1985, 1992). A study design that omits a causal variable from a domain therefore will produce biased estimates of the effects for variables that are included in the study (cf., James, Mulaik, & Brett, 1982, pp. 71-80). For example, a substantial body of evidence suggests that hostility increases the risk of accidents. The omission of hostility from a study therefore will result in models with biased estimates of the effects of other aspects of neuroticism such as anxiety, depression, stress vulnerability, and impulsivity. In extreme cases, the bias might be the only basis for apparent effects, so those effects would be spurious (Kenny, 1979). James et al. (1982) described the steps that must be taken to avoid this problem.

Research designs must include measures of hazard exposure. In some cases, behaviors that yield hazard exposure can be intervening variables in accident models (e.g., Sumer, 2003). In other cases, hazard exposure can be a suppressor variable. For example, a weak relationship of impulsivity with accident rates ($r < .14$) increased dramatically, controlling for exposure to physical demands (partial $r > .41$).

Hazard exposure also can be a source of omitted variable bias. The openness to experience findings may illustrate this role. Openness indicators were moderately related to accident rates in the initial analyses; the relationships were largely eliminated by controlling for hazard exposure. These associations may be side effects of personnel practices that tend to assign more intelligent sailors to jobs with low physical demands. A correlation between openness and physical demands results because openness is positively related to intelligence (Ackerman & Heggestad, 1997). The correlations between openness and accidents therefore can be explained as a by-product of a causal network in which they play no part.[4] In this case, omitting hazard exposure produced a spurious association, one that was entirely the product of bias (Kenny, 1979).

This study evaluated an ecological approach to the study of personality and accidents. Substantial ecological correlations were found. The discussion has acknowledged the ambiguity of those correlations, but the potential for stimulating thinking about group dynamics as a factor in accidents has been illustrated as well. When coupled with studies in which individuals were the unit of observation, the findings indicate that multilevel research designs could be a productive approach to understanding accidents. The practical importance of improving accident models is self-evident, so even equivocal evidence implicating group dynamics as contributing to this problem should be sufficient to encourage pursuit of this line of research. Those lines should be pursued if only to avoid known impediments to sound theory construction (i.e., confirmation bias, atomistic fallacy).

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[4] The data supported the personnel practices argument. Average occupational intelligence was negatively related to physical demands (r = -.591), accident rates (period 1, r = -.471; period 2, r = -.510), and Openness (r = .866). Correlations between average intelligence and average scores on openness facets ranged from r = .500 (Openness to Aesthetics) to r = .817 (Openness to Ideas).

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14. ABSTRACT (maximum 200 words)
Accident rates vary widely across U.S. Navy enlisted occupations. Incumbents' characteristics may affect rates, but the infrequency of accidents makes it hard to test this hypothesis by studying individuals. The study of aggregates is an alternative methodology that has not been applied to this problem. Therefore, this study related personality profiles to accident rates for 36 entry-level U.S. Navy occupations. Moderately strong associations showed that specific personality constructs (e.g., hostility) predicted accident rates better than broad personality dimensions (e.g., neuroticism). Higher average hostility, impulsiveness, excitement seeking, and disagreeableness and lower average gregariousness were related to higher accident rates. Occupational accident rates therefore may depend on the proportion of aggressive, antisocial individuals in the occupation. However, the behavior of high-risk individuals also may increase risks for friends and coworkers. The increases could be analogous to second-hand risk in smoking and to contagion models of antisocial behavior. The study of aggregate-level associations could shift the conceptual paradigm for accident research. Instead of focusing entirely on individual psychological dynamics, aggregate associations direct attention to the potential payoff from combining individual and group dynamics to provide better models of accidents. Multilevel modeling tools are available to evaluate this possibility.

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